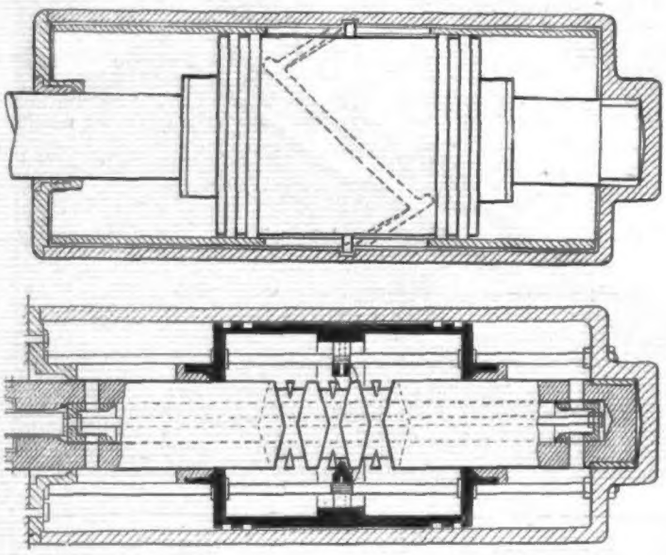
AN INFINITELY VARIABLE GEAR

Hydro-mechanical Device, Adaptable to Airscrew Hubs, Providing Semi-automatic Variation of Torque Ratio

A FORM of hydraulically controlled mechanical torque converter having infinitely variable characteristics over almost any range called for in vehicle transmission systems, has been designed by T. Watson Paterson, F.R.S.A., A.M.I.A.E., of 25, Sturdee Road, Liverpool, 13, who feels that it would lend itself to application as a self-contained and concentric coupling in an airscrew hub to provide a variable gear ratio.

It may be remembered that in his very thorough lecture to the Royal Aeronautical Society last year, Dr. H. C. Watts pointed out that for certain classes of aircraft a variable reduction gear ratio in addition to variable-pitch airscrew would be a necessity if full thrust horsepower was to be obtained. The incorporation of the Paterson torque converter in the hub of a v.p. airscrew would appear to offer certain problems, but investigation is proceeding.

The mechanism is, basically, a right- and left-hand (crossed) thread on the power shaft, on which is reciprocated a double-ended piston, the piston having inside its body a rocking nut which engages with the threads and travels up one and down the other continuously. Surrounding the piston is a cylinder which is free to rotate on the power shaft, but a continuous cam groove in the cylinder wall engages with studs on the piston (or *vice versa*) so that reciprocation of the piston results in rotation of the cylinder.



Two sections through the Paterson torque converter. In the upper is seen the reciprocating piston with its pins engaging the continuous cam groove in the outer cylinder. The lower shows the crossed thread on the power shaft, with its rocking "nut."

The overall reduction of speed between the driving shaft and the cylinder is, of course, a function of the pitch of the screw thread and of the cam groove. Thus, if the screw shaft rotates four times to one cycle of piston reciprocation and one piston cycle rotates the cylinder through half a revolution the ratio is 8 to 1, and so on. Of course, any ratio from, say, 1½ to 1 down to 30 or 40 to 1 may be selected, but whatever mechanical ratio is arranged becomes the lowest positive drive that will be provided and between it and a direct 1 to 1 ratio a hydraulic control gives an infinitely variable regulation.

This control is quite simply arranged. The double-ended piston reciprocates within, and rotates the cylinder. Obviously, if the reciprocation of the piston should be checked the whole assembly would be compelled to revolve as a solid mass at the speed of the screw driving shaft. To effect this impedance to piston reciprocation the spaces between the closed cylinder ends and the piston ends are filled with oil. A communicating duct is drilled through the driving shaft and controlled by a valve which opens or restricts both ends simultaneously. With the duct fully open the reciprocation of the piston is not impeded, the oil being transferred idly from end to end and the full mechanical "gear" reduction between drive shaft and cylinder is obtained. But as the duct is restricted the impedance to piston travel results in its tending to revolve with the drive shaft and in turn to carry the cylinder with it at the same speed.

Automatic Control

When the duct is closed completely the piston no longer reciprocates because the oil cannot be displaced, and the whole mechanism runs solidly as a unit. Actually the device can be made to function automatically, because if the oil ports and duct are dimensioned according to the power, speed and loading involved the restriction on oil transference from end to end of the cylinder will vary with the piston speed. Thus as the loading on the airscrew decreases the engine speed would tend to rise and with it the rate of the piston reciprocation. Beyond a certain rate the piston would be impeded by restriction of oil flow and the airscrew speed would then tend to rise, thereby imposing greater load on the engine, checking its increasing speed and re-establishing balance between power and load. External control, could therefore, be limited to complete closure of the transfer duct when stable conditions of normal power, speed and load were attained.

The mechanism, being entirely self-contained and concentric, should be adaptable to the hub of an airscrew. Should the hydraulic element fail for any reason, and particularly if the fluid should be lost, the low gear ratios (mechanical) would come automatically into operation.

CONCERNING COMPRESSION

OF the scores of components associated with the modern aero engine, there can be few, if any, demanding greater experience and manufacturing skill than piston rings. It is with these rings that the British Piston Ring Co., Ltd., of Holbrook Lane, Coventry, is chiefly concerned in the aeronautical field, though a recent inspection of the Brico works, every detail of which seems to make for the utmost efficiency, brought to light a number of additional items.

Apart from piston rings and scraper rings made to specification 4K6 and in the Brilybdenum (to Air Ministry specification—DTD.277) and Brimol materials developed by Brico, one was shown, or told of, such items as cylinder sleeves centrifugally cast in special alloys for sleeve-valve engines, cast-iron bushes, cylinder head rings, bearing retainer rings, and similar rings for various duties made in hardened and tempered high-speed steel.

At the company's near-by foundry it was possible to see cast-iron piston-ring "pots" (from which the rings are cut) being formed on special centrifugal casting machines. The molten metal is thrown outwards to the wall of the mould by the centrifugal force set up by high rotational speeds, and the casting cools while rotating. Impurities such as dirt and slag automatically separate out so that they can be removed.

A subsidiary company to the British Piston Ring Co., Ltd., and adjoining their imposing premises, British Aero Components, Ltd., specialise in aircraft valves, including the sodium-filled type, for the manufacture of which the Wilcox Rich Corporation of Detroit have granted them the remaining exclusivity on the patent rights. Interesting examples of this type of valve were seen in hand for the new Alvis aero engine. These had stellited faces and nitrided stems, for which processes the plant has excellent facilities, and it was observed that they were also working the Nitralloy patent of plating the valves in conjunction with the nitriding process to accelerate the nitrogen penetration on austenitic steels, most of the material being to Air Ministry Specification D.T.D. 49. Great care was taken with material inspection by the acid etching process at various stages during the machining operations of the valve, for material flaws, and also to detect nitriding penetration.